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December 2004

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### Recommended Citation

Yi, Yuandong; Wu, Zhaohui; and Tung, Lai, "Do Perceptions Fully Mediate the Impacts of Individual Differences on Technology Use?" (2004). *PACIS 2004 Proceedings*. 62.

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# Do Perceptions Fully Mediate the Impacts of Individual Differences on Technology Use?

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## Abstract

*IS researchers have long posited that perceptions fully mediate the influence of individual differences on technology use. However, anecdotal studies suggest that individual difference may have a direct effect on technology use. In this study, we aimed at exploring whether perceptions fully mediate the impacts of individual differences on technology use and whether individual differences influence two dimensions of technology use, i.e. frequency of use and hours of use, in the same way. Individual differences include personal traits, demographic variables, and situational variables. As demographic variables, age and gender are identified as variables of research of interest in our study. PLS was used to test our research model. Results show that individual difference may directly influence technology use and that individual difference variables influence frequency and amount of technology use in same ways, at least for the two variables we examined in our study, i.e. gender and age.*

**Keywords:** Gender, Age, Perceptions, Frequency of use, Hours of use

## 1. Introduction

Technology Acceptance Model (TAM) (Adams et al. 1992; Davis 1989) posits that perceptions such as perceived ease of use and perceived usefulness determine use of new technology. However, TAM failed to explicitly consider a set of important constructs, namely, individual differences (Agarwal and Prasad 1999). In this study, we aim at exploring the effects of individual differences on technology use.

Based on theory of reasoned action (Ajzen and Fishbein 1980), Davies et al. (1989) suggested that internal beliefs fully mediate the effects of external variables such as individual differences, situational constraints and managerially controllable interventions on behavior. Agarwal and Prasad (1999) also hypothesized that the effects of individual differences on technology acceptance are fully mediated by an individual's perceptions about an information technology. The theoretical underpinnings of such an argument are rooted in the field of social psychology (Ajzen and Fishbein 1980). However, anecdotal studies have shown that the effect of individual

difference on technology use may not be fully mediated by perceptions. For example, Morris and Venkatesh (2000) found that age has a negative direct effect on long-term technology usage.

Many previous studies regarding technology use used behavior intention as the dependent variable (Agarwal and Karahanna 2000; Agarwal and Prasad 1999; Cheung et al. 2002; Dabholkar and Bagozzi 2002; Davis 1989). However, it is more interesting to examine actual technology use than behavior intention since the ultimate goal of new technology vendors is to encourage more actual use of their technologies by customers. Nevertheless, only a few researchers have examined actual technology use. Among these researchers, some failed to differentiate between two dimensions of technology use, i.e., frequency of use and amount of use, or failed to examine both dimensions simultaneously. For example, these studies (Davis 1989; Davis et al. 1989; Morris and Venkatesh 2000; Venkatesh and Morris 2000) only examined the frequency of actual use while some other studies (Gefen and Straub 1997; Venkatesh and Davis 2000; Venkatesh et al. 2003) only examined amount of actual use (e.g. hours of use, number of emails received and sent, etc.). Only a small portion of studies examined both dimensions of actual technology use (Adams et al. 1992; Davis 1993; Venkatesh 2000). As a result, we do not have a clear idea regarding whether individual difference influences frequency of use and amount of use in the same way.

Accordingly, in this research, we try to explore the following two research question:

- Do perceptions *fully* mediate the influence of individual difference on technology use?
- Do individual differences influence the frequency of use and the amount of use in the same way?

## **2. Conceptual Background**

### ***2.1 Technology Acceptance Model***

Technology acceptance model states that people's use of a new technology (USE) is fundamentally determined by two specific perceptions, namely perceived usefulness (PU) and perceived ease of use (PEOU). In addition, PU is posited to be affected by PEOU since effort saved due to improved ease of use may be employed to increase performance via enabling a person to accomplish more work with the same effort. Furthermore, researchers have identified subjective norm (SN) as an important determinant of technology use (Venkatesh and Davis 2000). SN is also posited to affect PU in this study, consistent with TAM 2 (Venkatesh and Davis 2000).

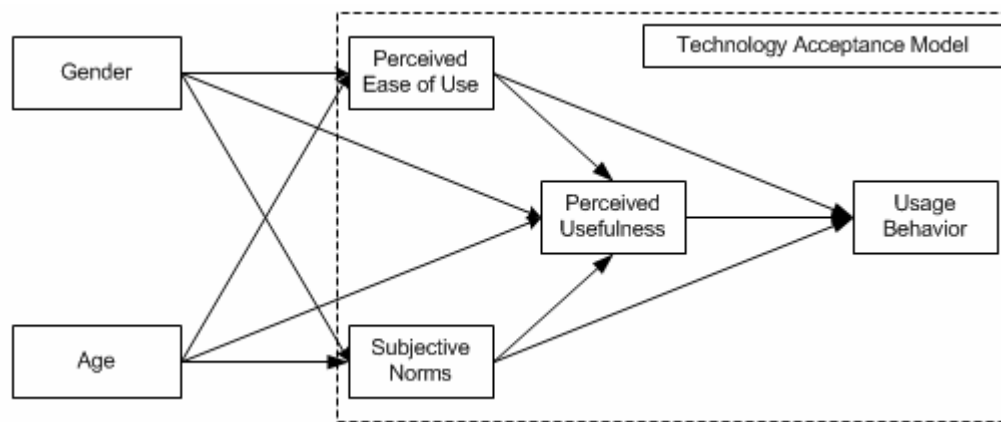
Although many researchers retained the "beliefs→attitudes→behavior intention→actual use" framework, some others (Adams et al. 1992, Davis 1989, Venkatesh and Davis 2000, Venkatesh et al. 2003) have ignored attitude and/or behavior intention and instead studied the direct effects of PEOU and PU on usage. To maintain model brevity and permit the study of the effects of individual differences, the current research similarly studied the direct effects of PU, PEOU, and SN on technology use. Figure 1 presents the basic TAM model used in the current study.

### ***2.2 Individual Difference Variables***

Consistent with Agarwal and Prasad's (1999) studies, individual differences include personal traits, demographic variables, and situational variables that account for differences attributable to circumstances such as experience and training. The following factors were identified as variables of research of interest: age, and gender. Age and gender were selected as demographic variables. These two variables were selected in that previous studies have suggested or indicated that they may influence technology use.

### 3. Research Model and Hypotheses

Based on the above discussions, we have the research model which is shown in figure 1 to be empirically tested in this study. The research model shows that perceptions, i.e. PU, PEOU, and SN, fully mediate the impacts of age and gender on usage behavior.



**Figure 1 Research Model**

#### 3.1 Hypotheses

##### 3.1.1 Gender

Since it has been found that women typically experience high levels of anxiety in using computers compared with men (Bozionelos 1996; Frankel 1990; Morrow et al. 1986), and that computer anxiety and compute self-efficacy negatively correlate (Hunt and Bohlin 1993), “higher levels of computer anxiety among women can be expected to lead to lowering of self-efficacy, which in turn could lead to lower of ease of use perceptions” (Venkatesh and Morris 2000, p.119). Furthermore, men’s relative tendency to feel more at ease with computers has been demonstrated in IS literature by Gefen and Straub (1997), who found that males perceived more ease of use of e-mail than females. Now that men generally perceive a new technology easier to use than women do, women may find the new technology less useful, at least in terms of reducing the efforts to use the new technology. Furthermore, since women typically display lower computer aptitude than men, it is less likely for females to explore the usefulness of the new technology to the same extent as for males. Thus, we also expect that males will perceive a new technology more useful than females. Studies have shown that women tend to be more sensitive to others’ opinions (Miller 1976). It is reasonable to expect that they would be more

likely than men to notice the social influence from peers, supervisors and so on. By citing Rosenkrantz et al.'s studies (1968), Venkatesh and Morris (2000) noted that women have a greater awareness of others' feelings than men. Accordingly, we believe that women have higher levels of perceptions of social norm than men.

H1:

- a) Women's perception of ease of use of a new technology will be lower than men's.
- b) Women's perception of usefulness of a new technology will be lower than men's.
- c) Women's subjective norm regarding a new technology will be higher than men's.

### **3.1.2 Age**

Previous studies have shown that age is associated with difficulty in processing complex stimuli and allocating attention to information on the job (Plude and Hoyer 1985). Morris and Venkatesh (2000) noted that older individuals appear to have problems with both accessing and retrieving information from memory. Furthermore, Hubona and Kennick (1996) reported a negative relationship between age and perceived ease of use. Lower perceived ease of use, a known antecedent of perceived usefulness, may result in lower perceived usefulness. Morris and Venkatesh (2000) also argued that, in the short term, age will have a positive direct influence on subjective norm. Their data showed a significant positive relationship between age and subjective norm (p.389).

H2:

- a) Old individuals' perception of ease of use of a new technology will be lower than young individuals'.
- b) Old individuals' perception of usefulness of a new technology will be lower than young individuals'.
- c) Old individuals' subjective norm regarding a new technology will be higher than young individuals'.

## **4. Research Design**

One study was conducted to test the research model. Undergraduates of business school in a local university were chosen as our research subjects. We chose them because: 1) they were being introduced to a new technology, a statistical program then; 2) before the introduction of the statistical program, subjects had no prior knowledge of the program; and 3) the use of the statistical program was voluntary for subjects in the study and subjects could use other means (such as Microsoft Excel) to realize the same functions provided by the new technologies to which they were introduced;. Online survey was used to collect data. Online survey is gaining acceptance in IS research (Bhattacharjee 2001; Tan and Teo 2000). The design and organization of the web pages were designed so that subjects were comfortable about the online survey. Pilot test was used and several rounds of revisions were made based on feedbacks.

Subjects in this study were 120 second-year undergraduates. They can use the program to conduct a wide range of data analysis such as regression. The subjects received three sessions of

training with two hours each session and one session each week. Eighty eight subjects completed the online survey.

#### **4.1 Measurement**

PU and PEOU were measured using items adapted from Davis (1989). Items measuring subjective norm were from Taylor and Todd (1995) (See appendix). We measured all these constructs using 5-point Likert scale (strongly disagree=1, strongly agree=5). We measured their self-reported program usage based on two dimensions, how often and how much. They were asked how many times they used the statistical program every week and how many hours they spent on the program every week, on average. The way we measure self-reported system usage is consistent with that was used in previous studies (Adams et al. 1992; Hubona and Kennick 1996).

#### **4.2 Procedure**

Three weeks after the students were first introduced to the statistical program, we administered the online survey. Since subjects were in different classes, one researcher went to each classroom just before class began, briefly introduced our research project to the students, informed them the address of our online survey, and asked them to complete the survey on the spot. Only one researcher was present in each classroom. Considering some students may choose to complete the survey later, the online survey lasted for one week. Sample characteristics were shown in table 1. About 60% of the sample is female, which is typical of the business student body at this university.

**Table 1 Sample characteristics**

	Mean	S. D.	Median	Maximum	Minimum	Missing
Age	20.84	1.082	20	23	19	0
Gender	Female Male	58% 42%				0

### **5. Data Analysis**

#### **5.1 Assessment of Reliability and Validity**

Psychometric properties of the perceived usefulness, perceived ease of use, and subjective norm were assessed in terms of discriminant validity and internal consistency. We used Partial Least Squares (PLS) to test the research model. The PLS procedure has gained interest and use among researchers in recent years largely because it is able to model constructs under conditions of non-normality and small to medium sample size (Chin 1998).

Confirmatory factor analysis results (table 2) from PLS show that, with one exception (PEOU2 with loadings of 0.692), all other items load very well to their corresponding constructs. We decide to retain the item since Chin (1998) suggested that “loadings of .5 or .6 may still be acceptable if there exist additional indicators in the block for comparison basis.” (p.325) Confirmatory factor analysis results from PLS also show that all items load more on their own

factor than on other factors. The fact that average variance extracted (AVE) for all latent constructs is greater than .50 and that the square root of AVE is greater than the correlations among the latent variables as shown in table 4 also suggests that discriminant validity has been established. These results therefore confirm that each of these constructs is unidimensional and distinct and that all items used to operationalize a particular construct load onto a single factor.

**Table 2 Factor analysis: PLS results, loadings and cross-loadings for the measurement model**

	PEOU	PU	SN
PEOU1	0.816	0.154	0.049
PEOU2	0.692	0.062	0.016
PEOU3	0.801	0.175	-0.03
PEOU4	0.82	0.306	0.033
PU1	0.212	0.86	0.151
PU2	0.176	0.909	0.192
PU3	0.193	0.901	0.148
PU4	0.276	0.904	0.268
SN1	0.085	0.094	0.802
SN2	-0.021	0.261	0.918
Composite reliability	0.86	0.94	0.85

Note: PEOU=Perceived Ease of Use, SN=Subjective Norm, PU=Perceived Usefulness,

As a measure of internal consistency, composite reliability is also calculated for all the constructs. Results show that the composite reliability of all constructs is higher than 0.85.

Descriptive statistics for the research constructs were shown in table 3. The results suggest that subjects perceive the statistical program to be useful (mean=3.41) while they do not think that it is very easy to use (mean=2.87). Meanwhile, results show that they believe their instructors or peers expect them to use the program (mean=3.66) though use of the program is completely optional.

**Table 3 Descriptive statistics**

	Mean	Std. Deviation
Perceived Ease of Use	2.87	.75
Perceived Usefulness	3.41	.78
Subjective Norm	3.66	.66
Times of Use	.77	.58
Hours of Use	1.43	1.71

**Table 4 Inter-Construct Correlations**

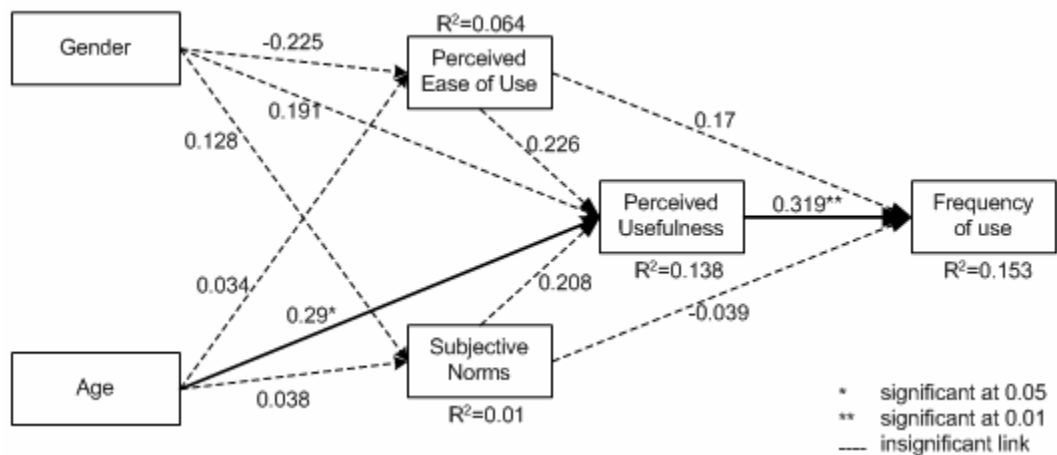
	PEOU	PU	SN
PEOU	0.615		
PU	0.248	0.799	
SN	0.024	0.223	0.743

Note:

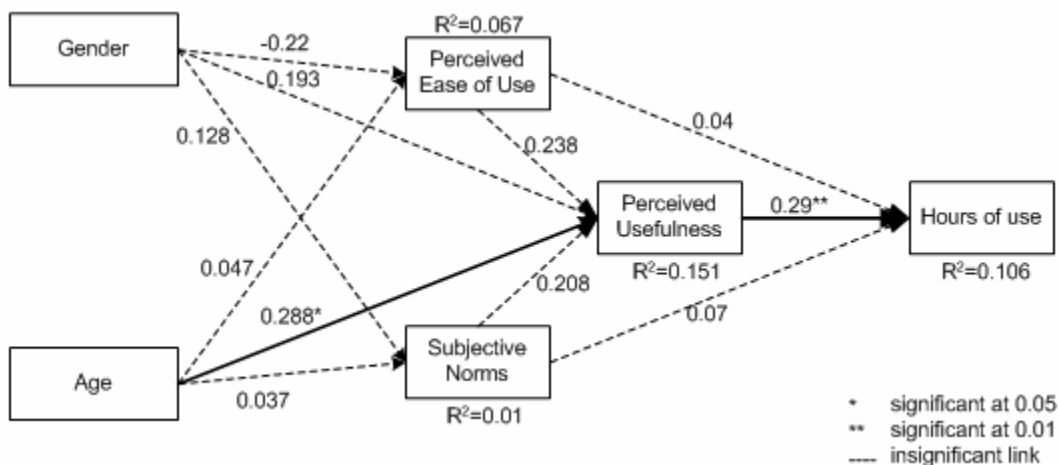
- 1) SN=Subjective Norm, PEOU=Perceived Ease of Use, PU=Perceived Usefulness,
- 2) The shaded numbers are square roots of the Average variance Extracted (AVE)

## 5.2 Results

The data were analyzed using PLS Graph Version 2.91.03.04. We opted to use bootstrap resampling (200 resamples) for significance testing of path estimates since “the jackknife is viewed as less efficient than the bootstrap” (Chin 1998) and computational time is not a problem for us. The path coefficients and explained variances for our research model are shown in figure 2 and figure 3 with frequency of use and hours of use as dependent variable respectively.



**Figure 2 PLS results for fully mediated model**

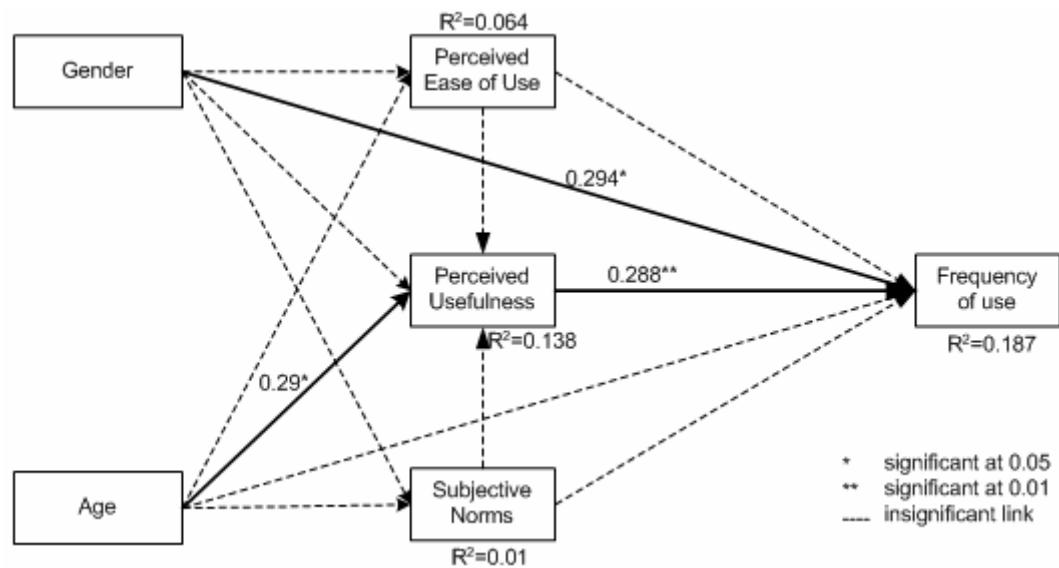


**Figure 3 PLS results for fully mediated model**

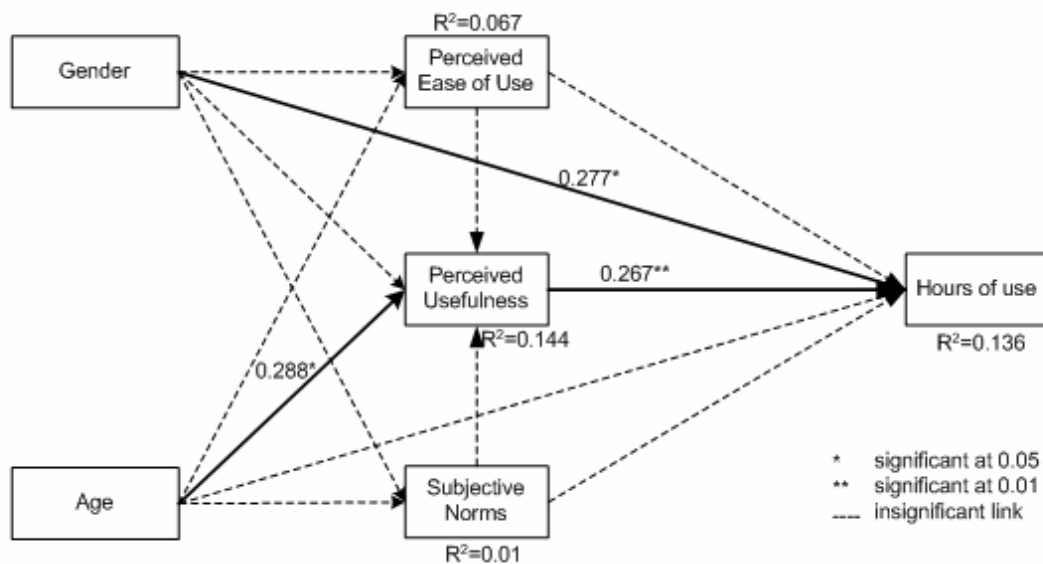
Results show that the only significant link between individual differences and perceptions is AGE-PU relationship. Gender does not indirectly affect perceptions regarding a new technology at all. PU is the only significant antecedent of technology use in terms of either frequency of use or hours of use. As can be seen from the above results, our fully mediated research model represented in figure 1 is poorly supported. Since previous studies have suggested that gender does have influences on behavior, we empirically tested the partially mediated models to make sure whether perceptions really fully mediate the influence of individual differences on



technology use. Figure 4 and figure 5 show the PLS results. For simplicity, path coefficients of insignificant links are not shown in the figures.



**Figure 4 PLS results for partially mediated model**



**Figure 5 PLS results for partially mediated model**

Figure 4 indicates that gender directly affects frequency of technology use and that age indirectly affects frequency of technology use through perceived usefulness. Figure 5 suggests that gender directly affect hours of technology use and that age indirectly affects hours of technology use through perceived usefulness. In sum, figures 2 and figure 5 indicate that gender influences technology use directly and that age indirectly affects technology use through PU however

technology is measured. Summary of findings were shown in table 5.

**Table 5 Summary of findings**

	Relationship	Findings
H1	Gender → perceptions	<ul style="list-style-type: none"> <li>• Gender does not influence PEOU, PU, and SN.</li> <li>• Gender influences the use of technology directly</li> </ul>
H2	Age → perceptions	<ul style="list-style-type: none"> <li>• Age positively affect PU.</li> <li>• Age does not influence PEOU and SN.</li> <li>• Age indirectly influences technology use through PU.</li> </ul>

## 6. Discussion and Conclusions

Motivated by the need to better understand the role of individual differences in people's use of new technologies, the study incorporated two demographic variables (gender and age) into technology acceptance model. We devote the following sections to discussions of the effect of each variable on technology use.

Information provided by figure 4 and 5 suggests that gender does have an influence on both frequency of use and hours of use of new technologies such that females use the statistical program longer and more often every week than males. However the influence of gender on technology use is neither through perceived ease of use, perceived usefulness, nor through subjective norm. Gender influences the use of technology directly. Females and males do not perceive differently in terms of effort, usefulness, and social influence from others. Such a finding is different from Gefen and Straub (1997)'s finding. They reported that gender influences use of email indirectly through perceived usefulness and SPIR (social presence and information richness of the medium). One possible reason for our findings is the subjects. We used business school undergraduates as our subjects. These mixed findings regarding gender calls for more research in such an area.

Perceptions, specifically perceived usefulness, fully mediate the influence of age on both frequency and hours of use of a new technology. The finding is consistent with the report that the effect of age is fully mediated by TPB (theory of planned behavior) constructs (Morris and Venkatesh 2000). However, our results show that the older an individual, the more useful he or she perceives a new technology, and ultimately more frequently and longer he or she uses the technology. Such a finding is just the opposite of Morris and Venkatesh's (2000) findings. Nevertheless, our finding is not unexpected considering that for college students age may be a driver of technology use rather than a hurdle. Understandably, the older and the maturer a student is, the higher the ability he or she has to use a new technology in a beneficial way. Furthermore, an older student is likely to explore the functions provided by a new technology to a larger extent than a younger student, leading higher perception of usefulness of a new technology. Accordingly, older students use a new technology more often and longer than younger students.

## 7. Implications for Theory and Research

The study contributes to research in the following ways. First of all, the study clearly shows that perceptions may not fully mediate the effect of individual difference on technology use. Models

based on TRA have long posited that perceptions fully mediate the influence of individual differences on technology use. However, we challenged such a proposition and found that some individual difference variables (e.g. gender in our study) influence technology use directly and have no influence on perceptions at all in some settings. Secondly, we found that individual difference influence frequency of actual technology use and amount of actual technology use in the same way, at least for the two variables we examined in our study, i.e. gender and age.

## 8. Limitation and Future Research

This study also suffers from several limitations. One limitation is that we use student sample to test our several research models. Future studies should try to validate the findings of this study in organizational settings. In this study, some findings regarding gender and age are different from previous studies' findings. Researchers are encouraged to explore whether the difference is from sample differences. Our study suggests that individual differences have the same effects on frequency of technology use and on hours of technology use. Future study may further explore the effects of other individual differences such as personal traits and situational variables on the two dimensions of technology use to test whether our findings can be generalized to other individual difference variables. Lastly, in this study, we only examine the issue regarding whether perceptions fully mediate the effects of individual difference variables on technology use. It is possible that individual differences influence technology use in other ways. For example, it should be interested to examine whether individual difference variables moderate the relationship between perceptions and technology use.

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## Appendix: Questionnaire Items

### *Perceived Usefulness*

- PU1      Using X<sup>1</sup> improves my performance in my studies
- PU2      Using X in my studies increases my productivity
- PU3      Using X enhances my effectiveness in my studies
- PU4      I find X to be useful in my studies

### *Perceived Ease of Use*

- PEOU1    My interaction with X is clear and understandable
- PEOU2    Interacting with X does not require a lot of my mental effort
- PEOU3    I find X to be easy to use
- PEOU4    I find it easy to get X to do what I want it to do

### *Subjective Norm*

- SN1      People who influence my behavior (e.g. my teacher, tutor, and peers) think that I should use X
- SN2      People who are important to me (e.g. my teacher, tutor, and peers) think that I should use X

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<sup>1</sup> X was replaced with the name of the statistical program when the survey was conducted.